A motor vehicle hinge assembly

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Abstract of **GB2386875**

A motor vehicle has a body structure and a bonnet pivotally connected towards a rear edge of the bonnet by at least one hinge assembly 10 and at least one actuator assembly 30 selectively operable to cause the rear of the bonnet to move from a lowered position to a raised position on actuation of the actuator assembly 30. Each hinge assembly 10 comprises a hinge mechanism 4 having a four bar linkage operable during normal use to pivotally connect the rear hinged bonnet to the body structure of the motor vehicle facilitating opening and closing of the bonnet. A locking means holds the hinge mechanism in its normal position until operation of the actuator releases the locking means and raises the rear edge of the bonnet. Preferably, sensor means 6 provide a signal indicating an impact to an electronic control unit 5 which forms part of the actuator assembly 30. Advantageously the hinge assembly 10 allows the rear edge of a rear hinged bonnet to rapidly lift during a collision such as with a pedestrian.

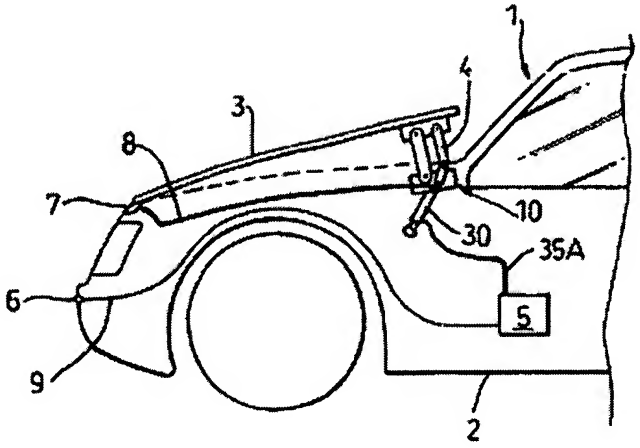

Fig. 2

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(54) Abstract Title
A motor vehicle hinge assembly

(57) A motor vehicle has a body structure and a bonnet pivotally connected towards a rear edge of the bonnet by at least one hinge assembly 10 and at least one actuator assembly 30 selectively operable to cause the rear of the bonnet to move from a lowered position to a raised position on actuation of the actuator assembly 30. Each hinge assembly 10 comprises a hinge mechanism 4 having a four bar linkage operable during normal use to pivotally connect the rear hinged bonnet to the body structure of the motor vehicle facilitating opening and closing of the bonnet. A locking means holds the hinge mechanism in its normal position until operation of the actuator releases the locking means and raises the rear edge of the bonnet. Preferably, sensor means 6 provide a signal indicating an impact to an electronic control unit 5 which forms part of the actuator assembly 30. Advantageously the hinge assembly 10 allows the rear edge of a rear hinged bonnet to rapidly lift during a collision such as with a pedestrian.

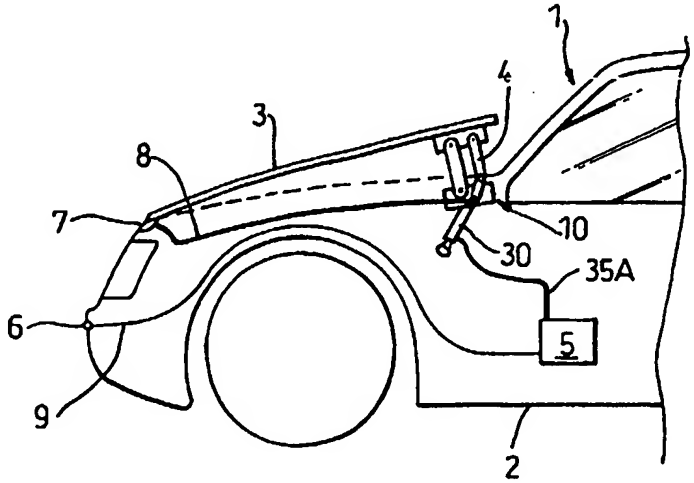

Fig. 2

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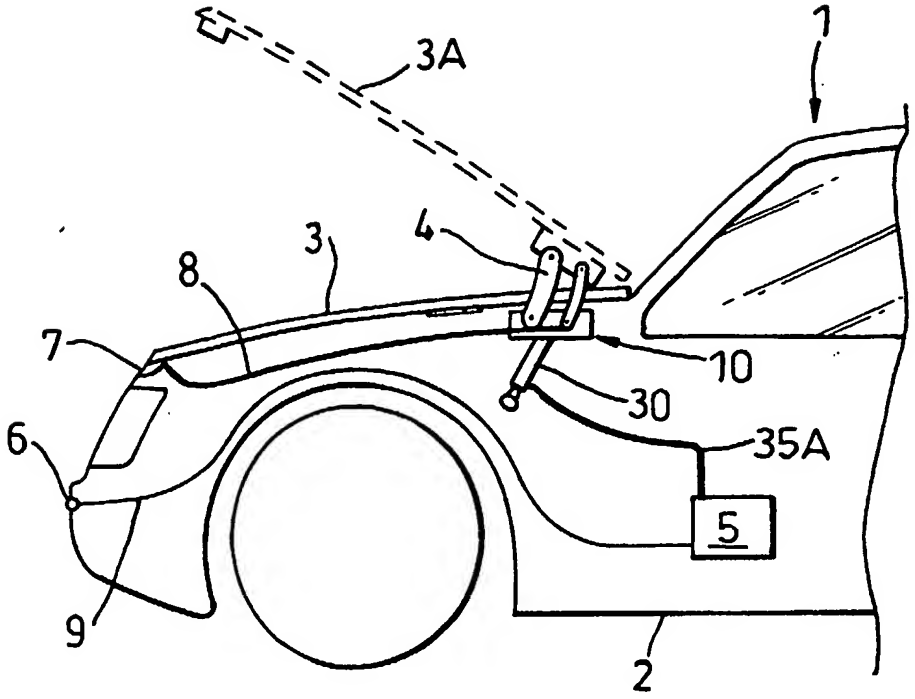

Fig. 1

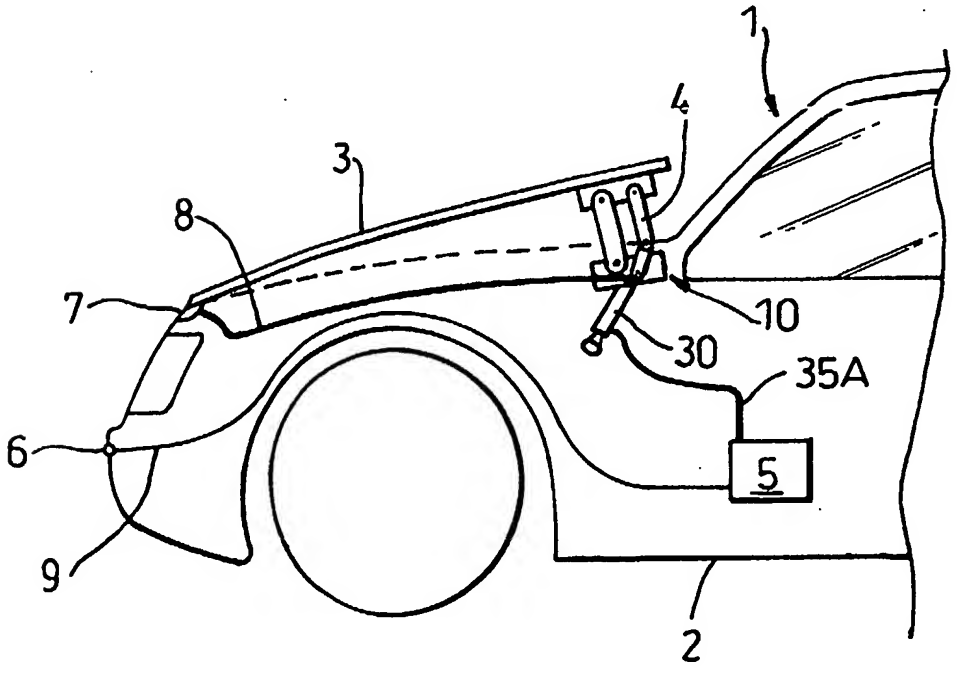

Fig. 2

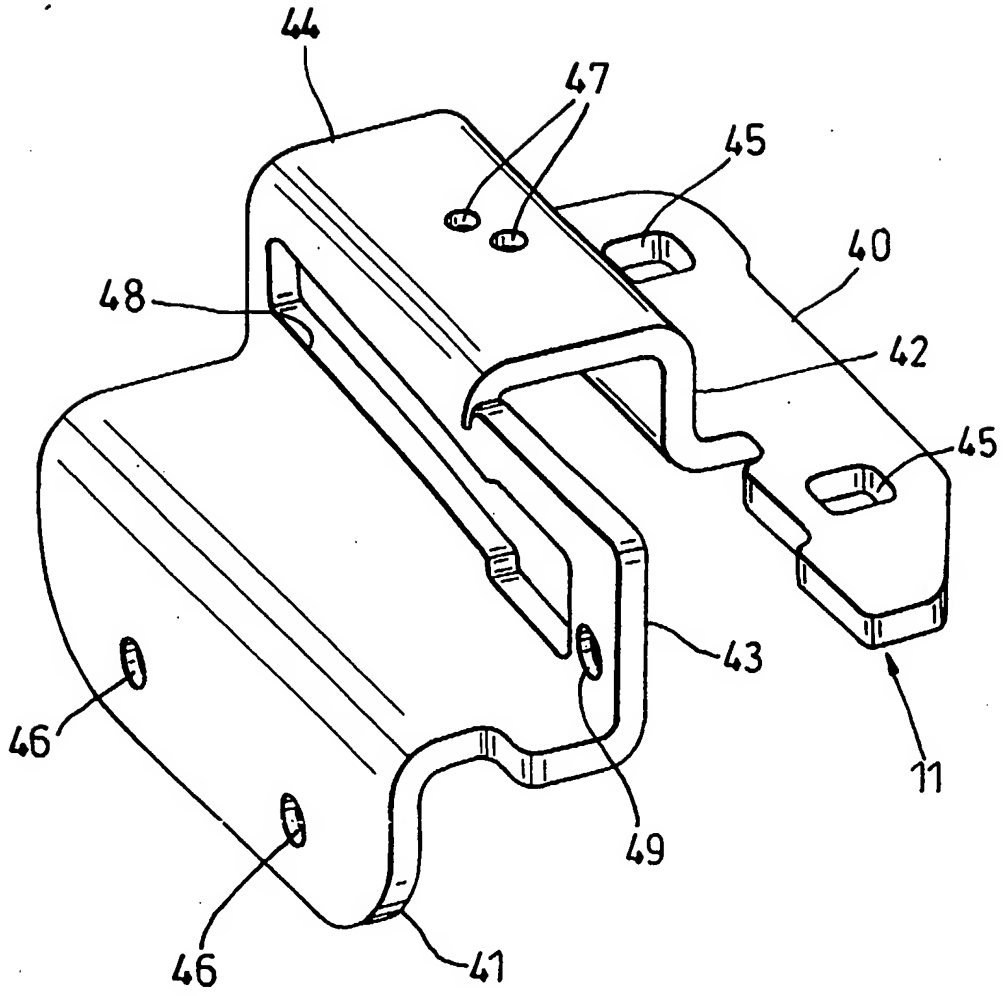

Fig. 3

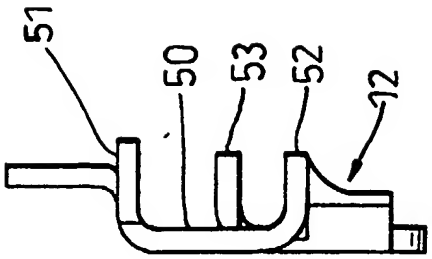

Fig. 5

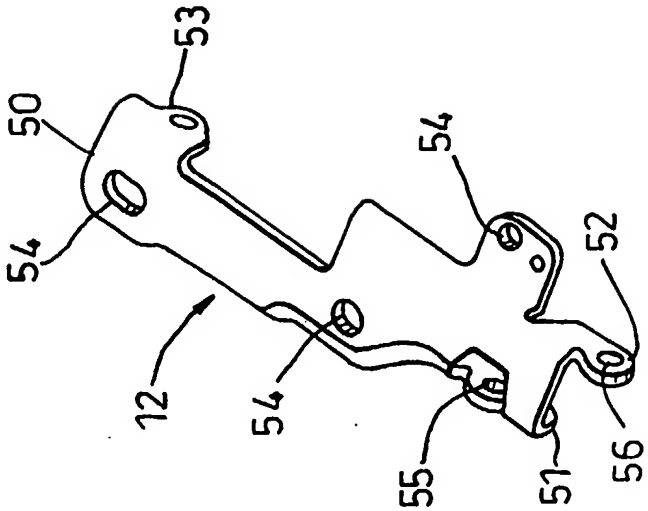

Fig. 7

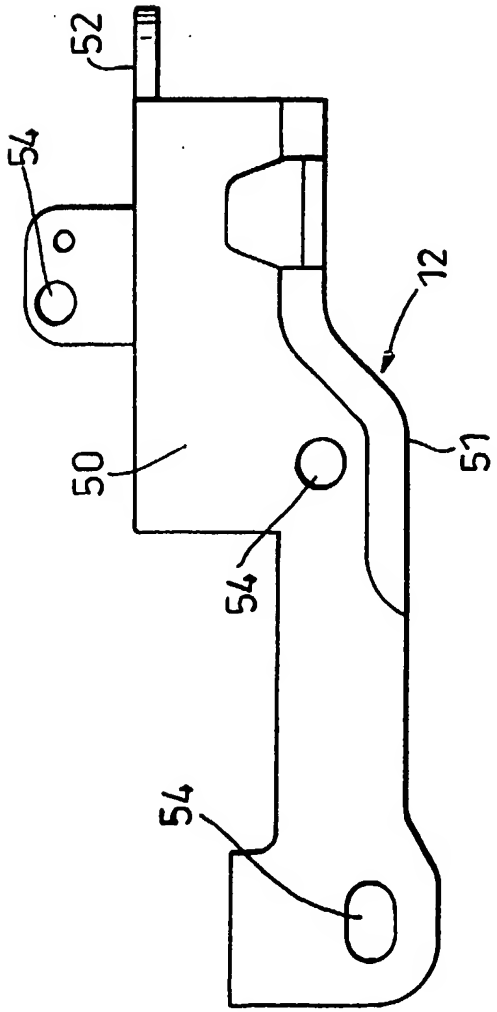

Fig. 4

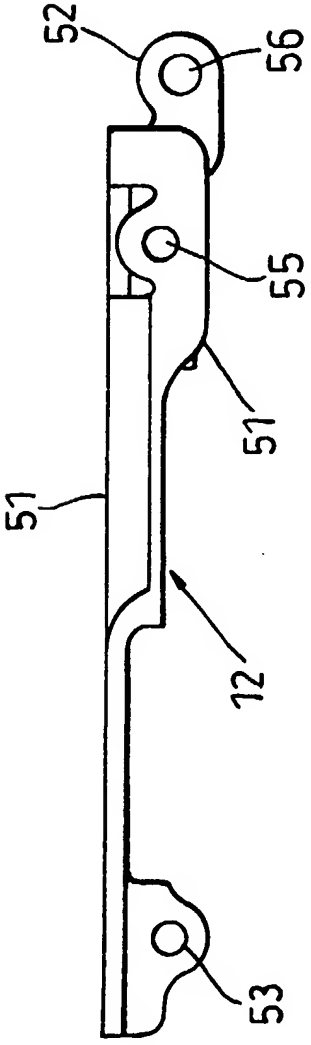

Fig. 6

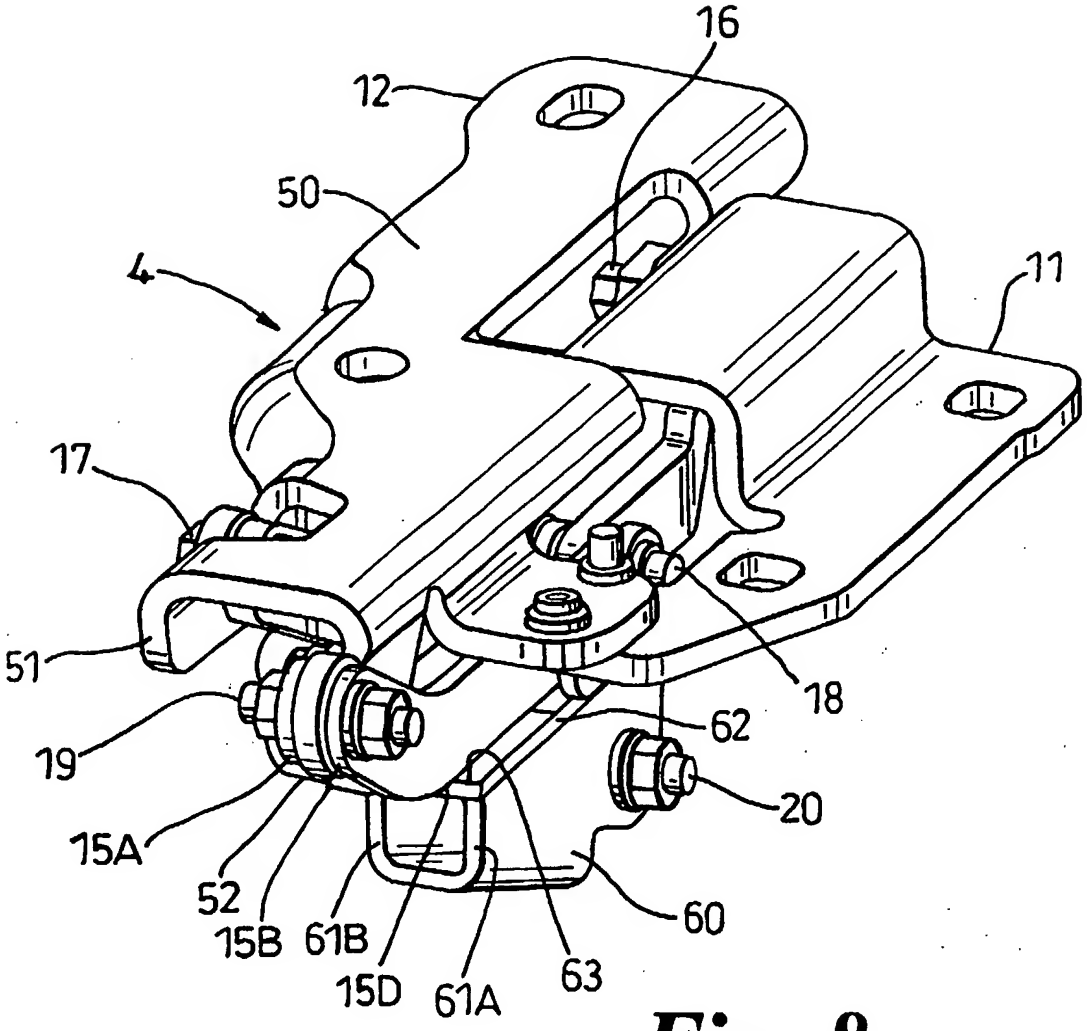

Fig. 8

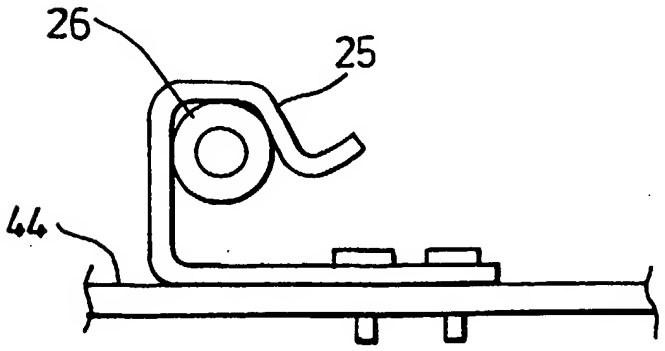

Fig. 13A

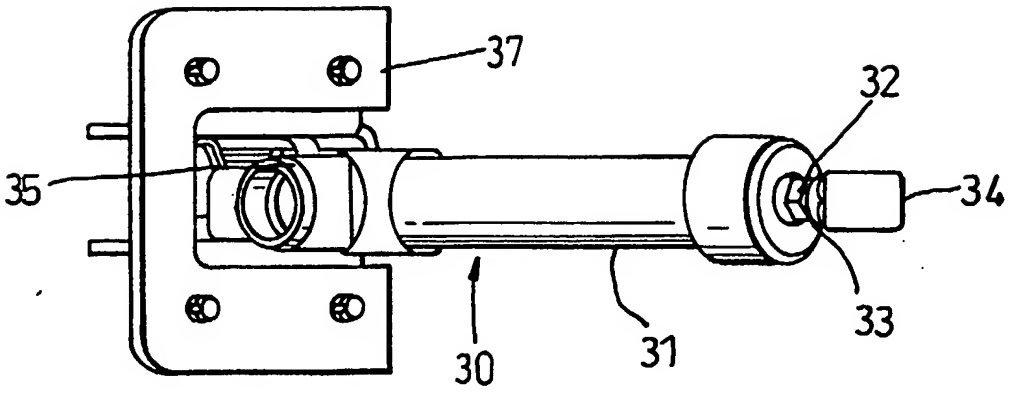

Fig. 9

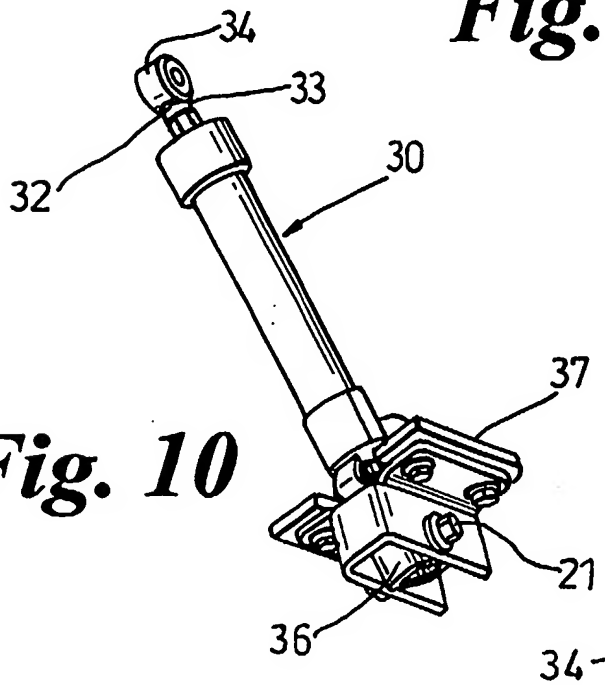

Fig. 10

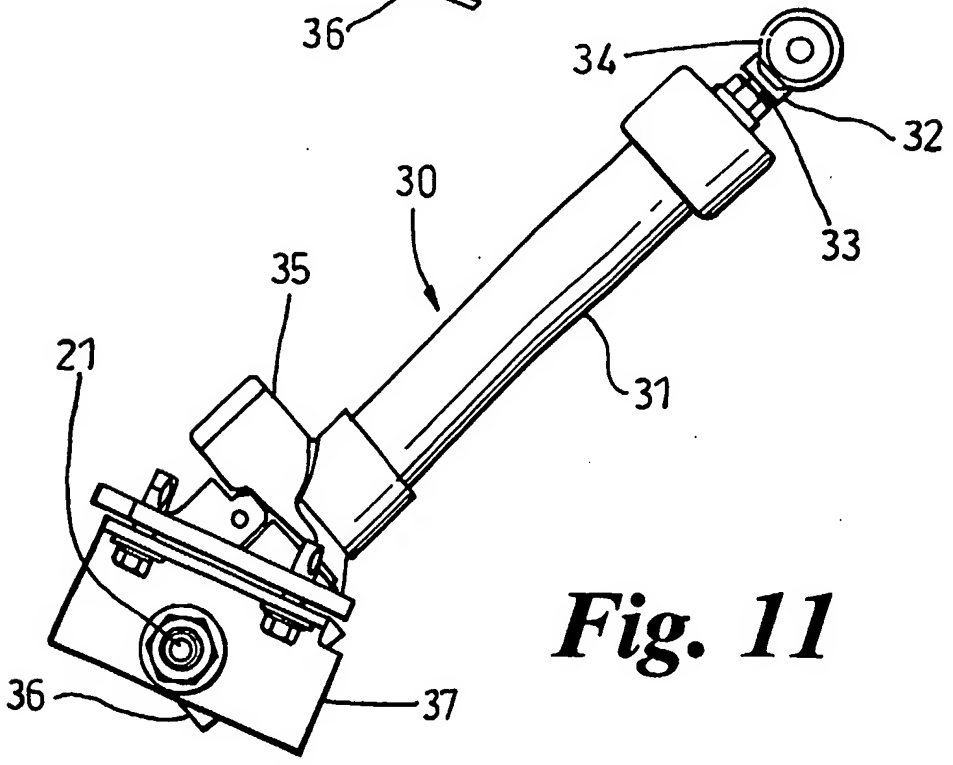

Fig. 11

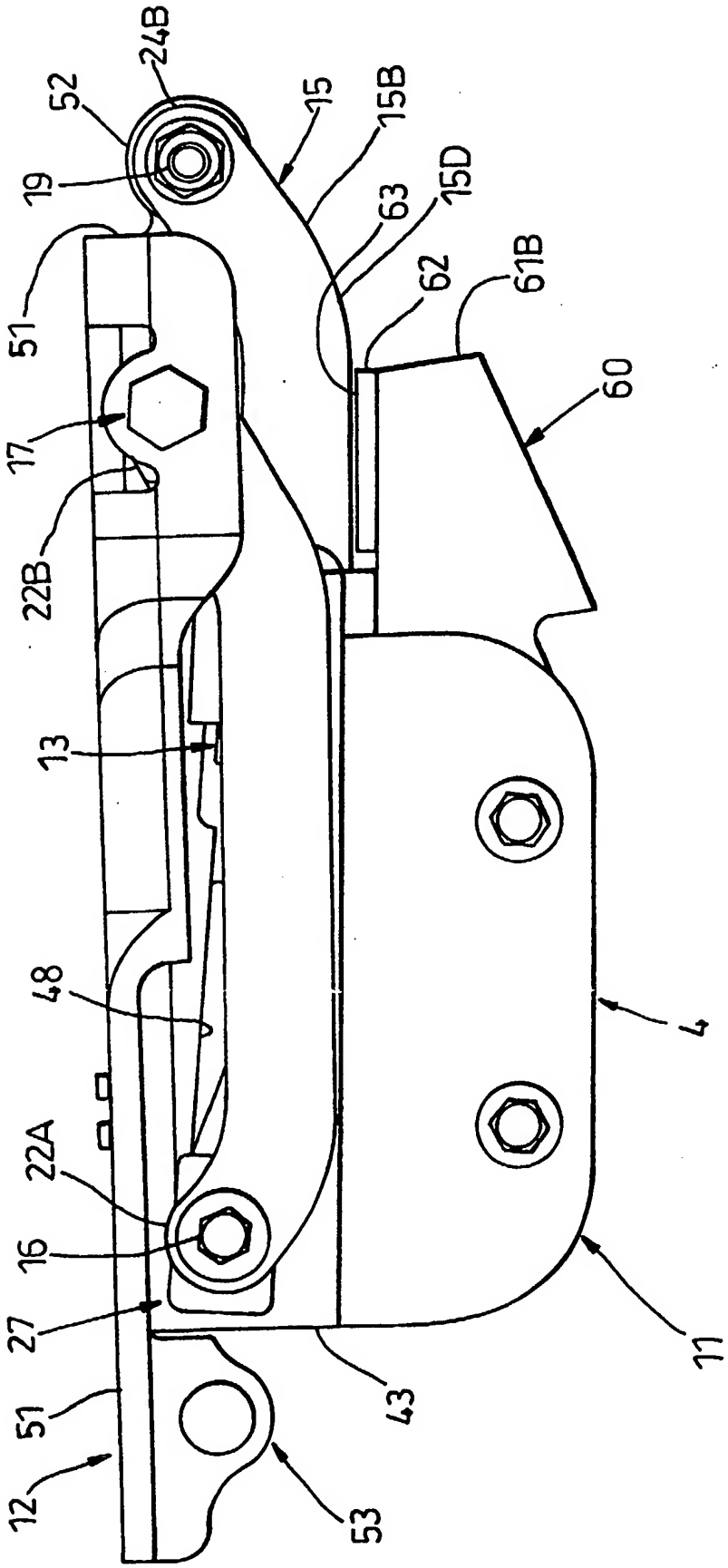
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Fig. 12

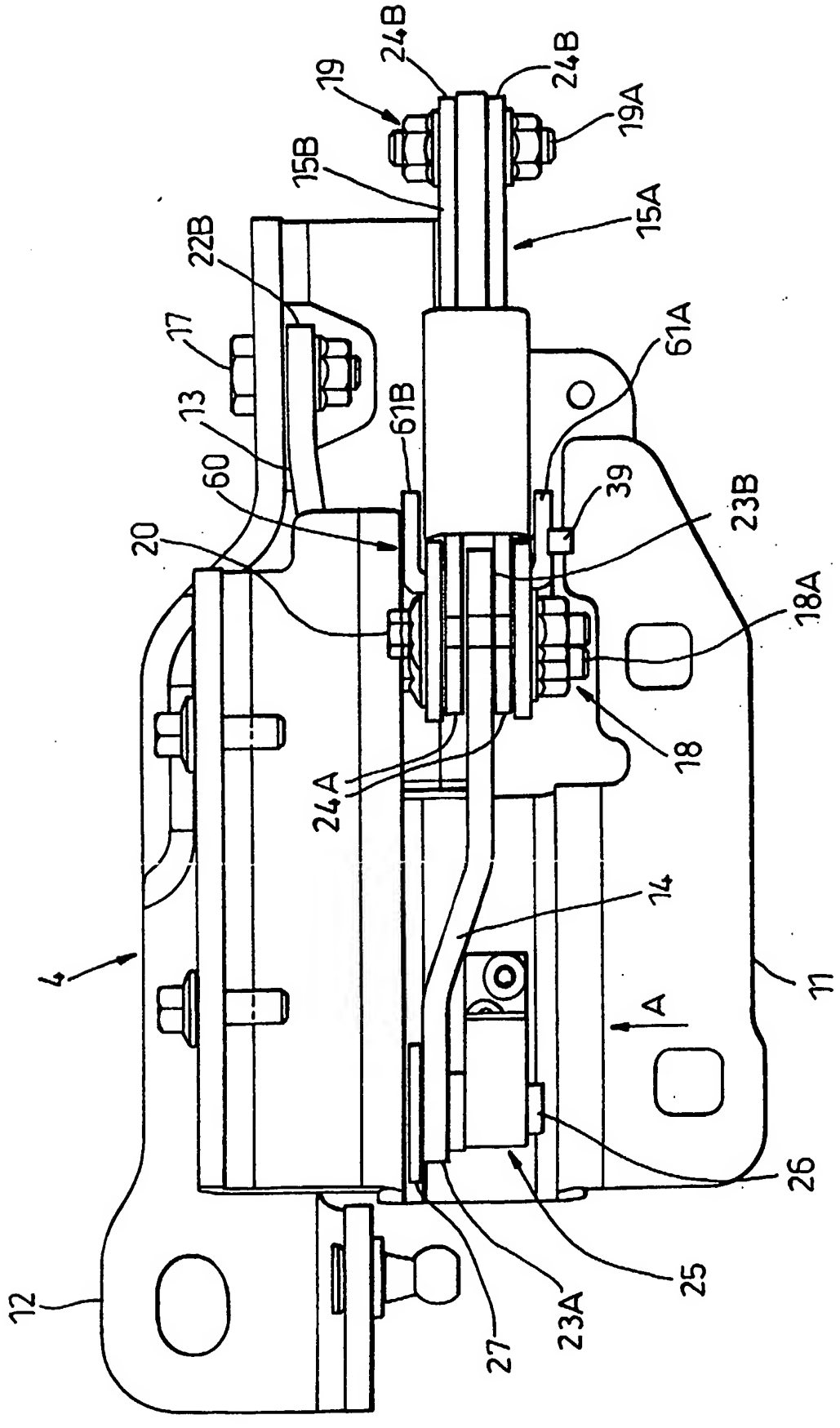
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Fig. 13

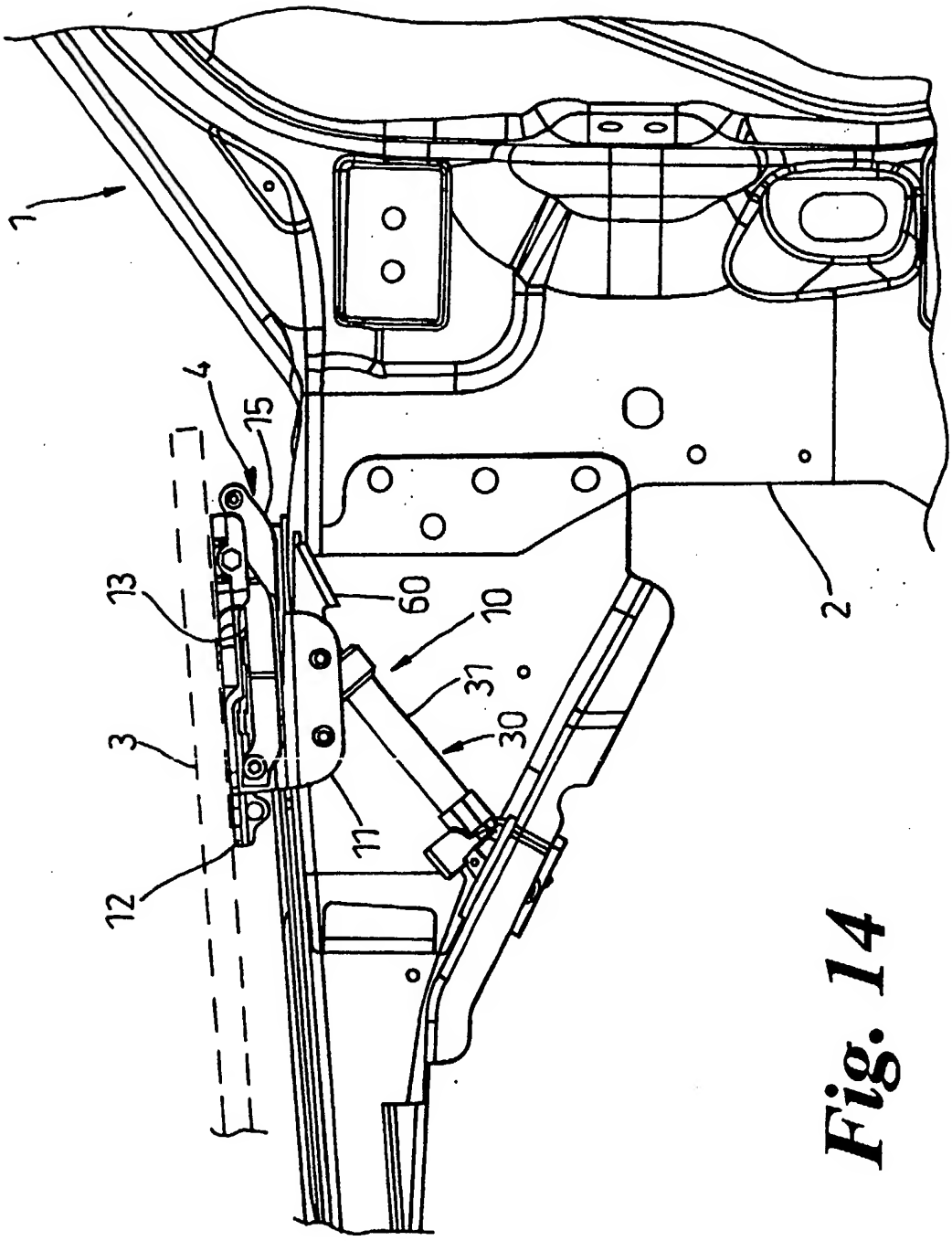

Fig. 14

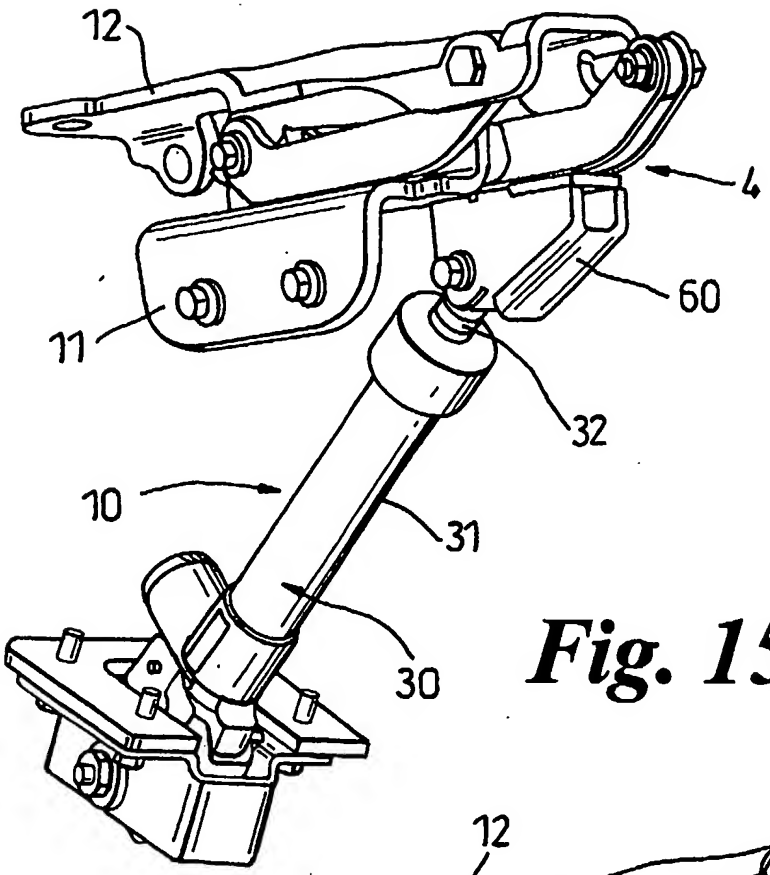

Fig. 15

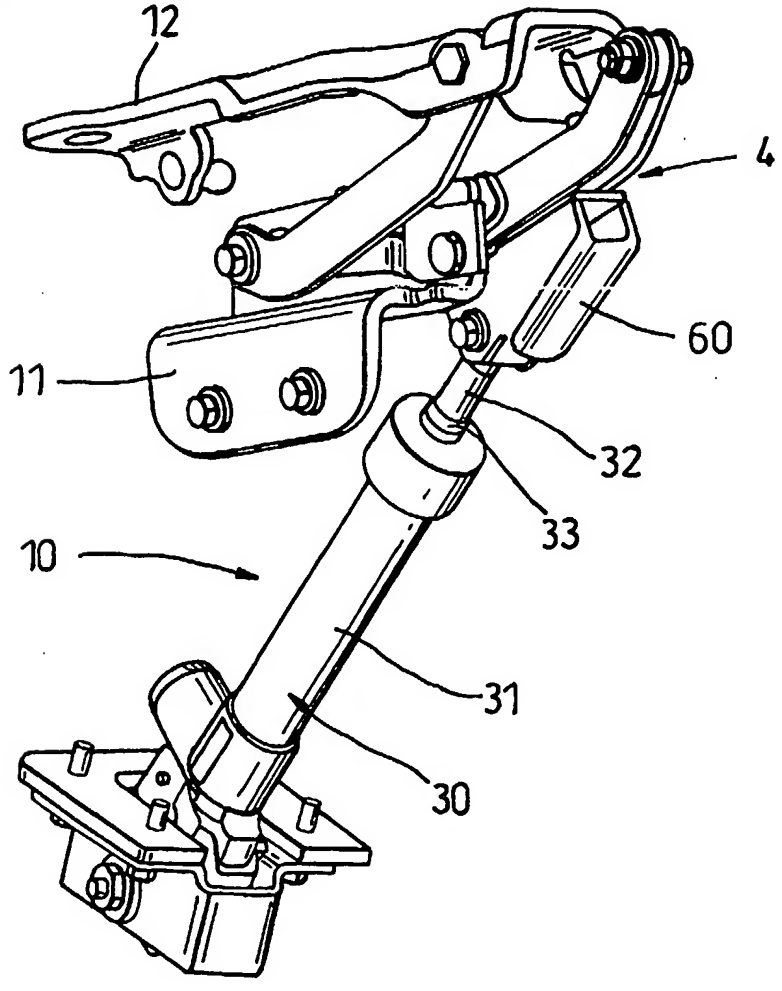

Fig. 16

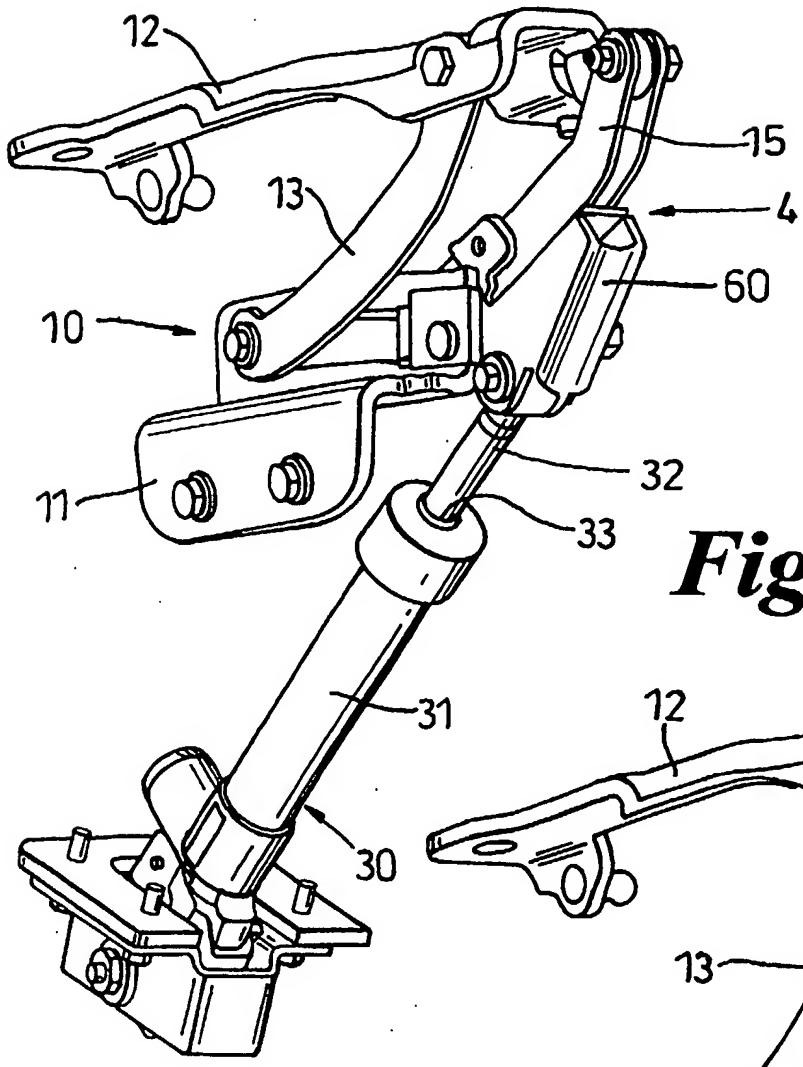

Fig. 17

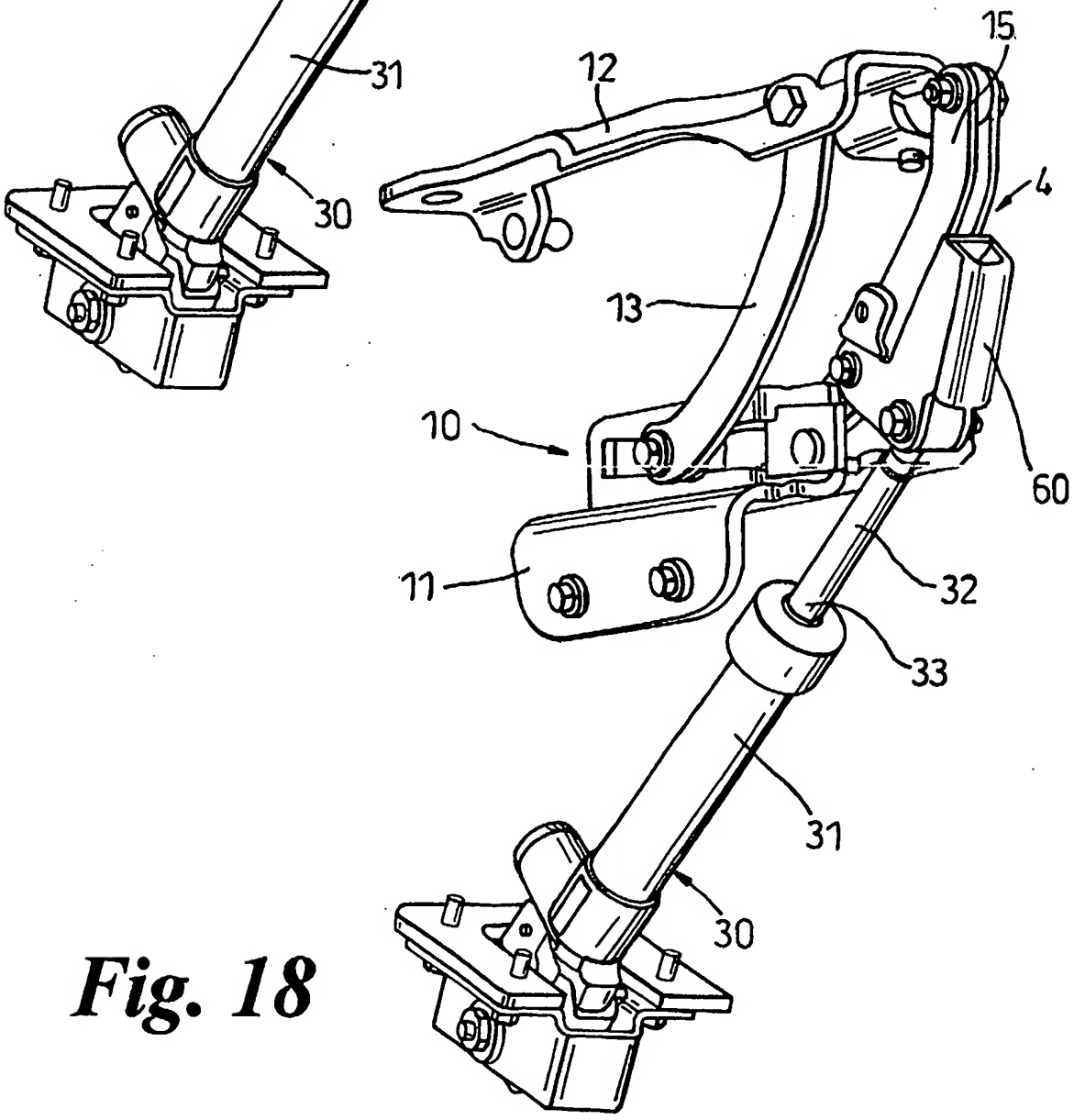

Fig. 18

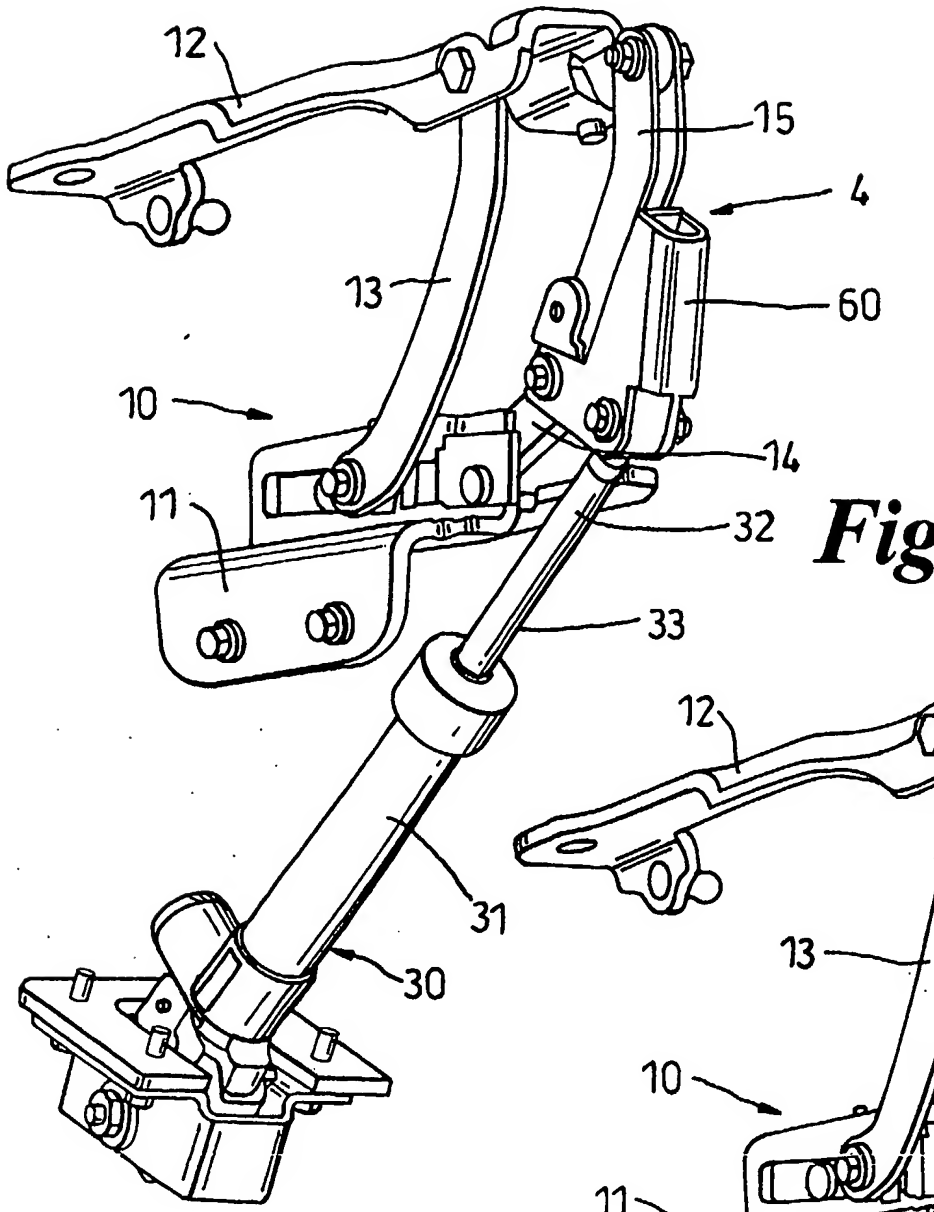

Fig. 19

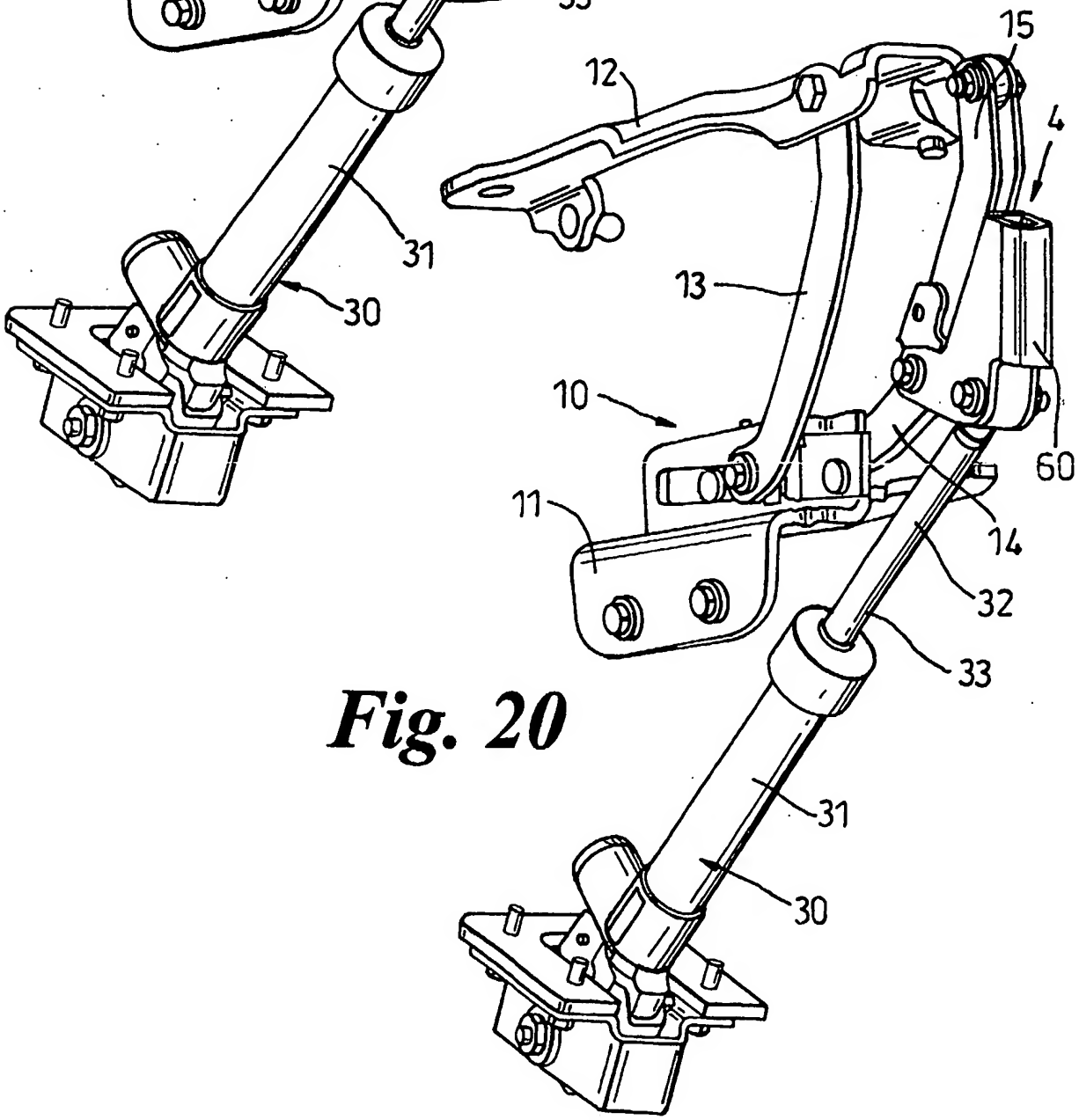

Fig. 20

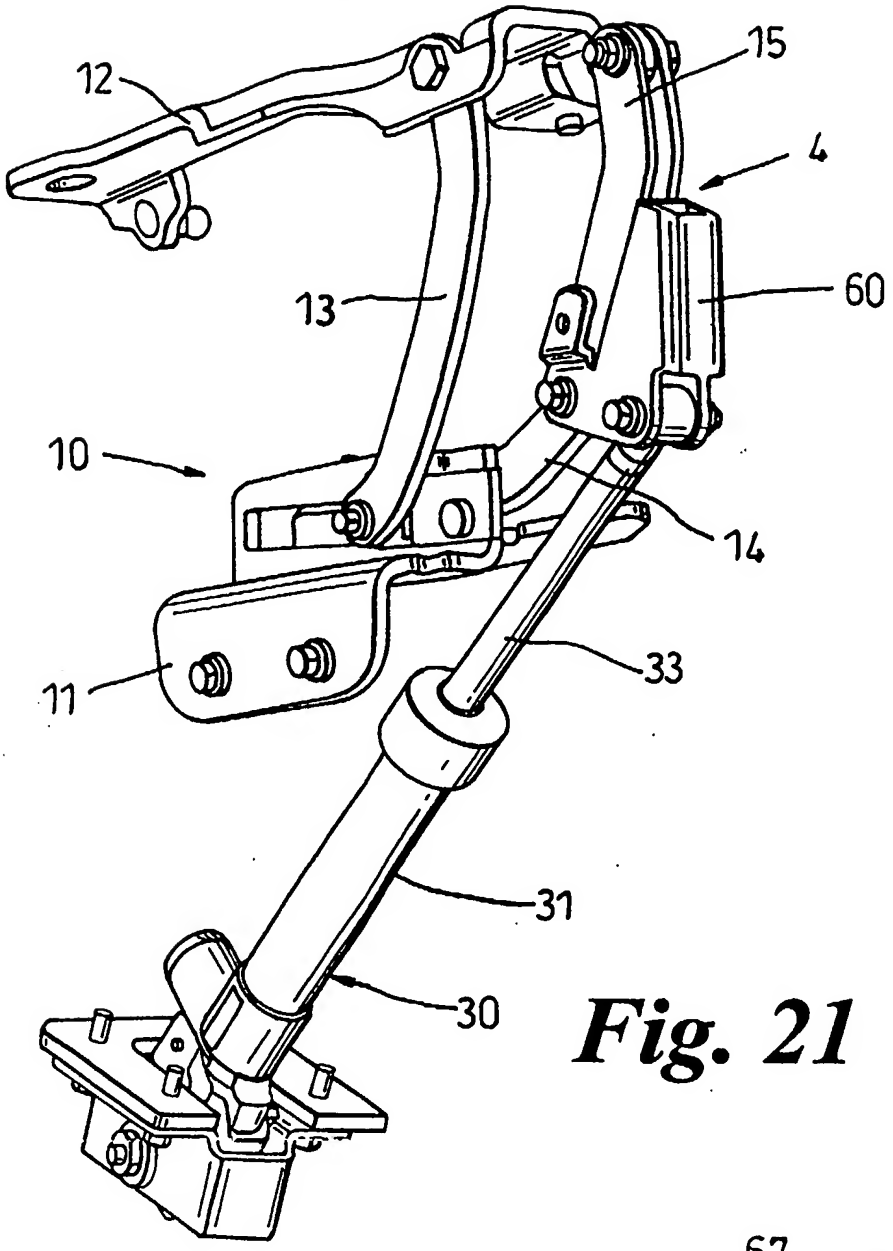

Fig. 21

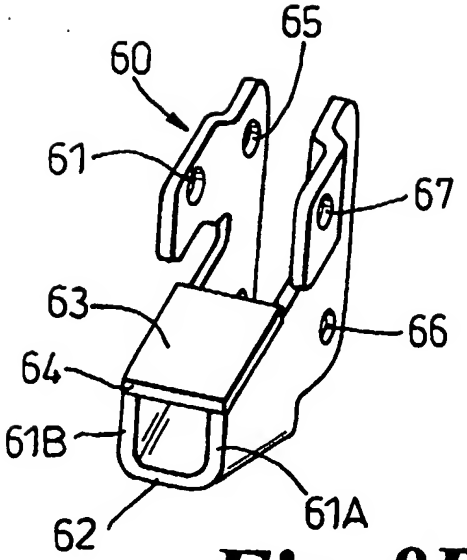

Fig. 8B

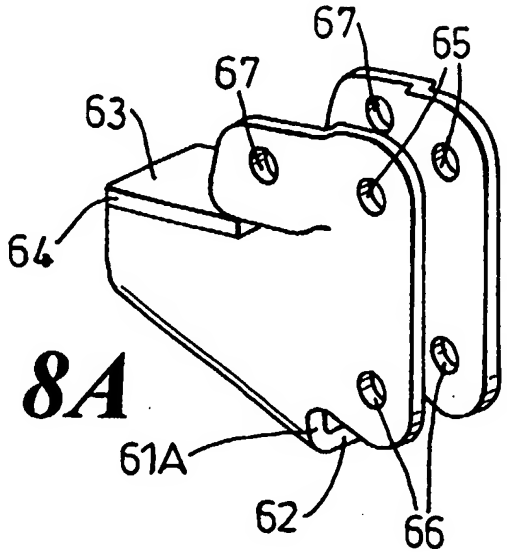

Fig. 8A

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A Motor Vehicle and a Hinge Assembly therefor

This invention relates to motor vehicles and to a hinge arrangement intended particularly, but not exclusively, for pivotally mounting a bonnet to a vehicle body. In some countries a motor vehicle bonnet is known as a hood or engine cover. However, the term bonnet will be used for consistency.

There are increasing demands for a motor vehicle designer to take account of pedestrian safety and, so far as possible, to design vehicles so that in an impact between a pedestrian and a vehicle the pedestrian has a reasonable chance of avoiding serious injury or death. In the case of a frontal impact between a moving vehicle and a pedestrian, the pedestrian is usually thrown onto the vehicle bonnet. If there is an empty space beneath the bonnet, the deformable nature of the bonnet itself can afford some protection because some of the energy of the impact will be absorbed by deformation of the bonnet. However, modern vehicle design also calls for no wasted space in the engine compartment and so there is usually a very limited amount of possible deformation of the bonnet before the impact is transmitted to unyielding engine components.

In order to avoid this problem it is known, for example from US-A-5697467, to provide a mechanism which lifts the rear edge of the bonnet in the event of an impact so that the energy of the pedestrian falling onto the vehicle can be absorbed by deformation of the bonnet. Such a mechanism is not however suitable for use with a rear hinged bonnet.

It is an object of the invention to provide a motor vehicle and a hinge assembly therefor which will allow the rear edge of a rear hinged bonnet to be rapidly lifted in the event of a pedestrian collision.

According to a first aspect of the invention there is provided a motor vehicle having a body structure and a bonnet pivotally connected to the body structure towards a rear edge thereof by one or more hinge assemblies and at least one actuator assembly selectively operable so as to cause the rear of the bonnet to be moved from its normal position to a raised position when the actuator assembly is actuated wherein each hinge assembly comprises a hinge mechanism having a four bar linkage operable during normal use to pivotally connect the rear hinged bonnet to the body structure of the motor vehicle so as to facilitate normal opening and closing of the bonnet and a locking means to hold the hinge mechanism in its normal position, the arrangement being such that the or each actuator assembly, when operated, releases the locking means and raises the rear edge of the bonnet.

When the locking means is released, a five bar linkage is formed which facilitates the raising of the rear edge of the bonnet.

Preferably, each actuator assembly is operatively connected to part of a respective hinge mechanism and is selectively operable to act upon said part of the hinge mechanism so as to cause the rear of the bonnet to be moved from its normal position to a raised position when the actuator assembly is actuated.

The vehicle may further comprise an electronic control unit and at least one sensor means mounted in a forward position on the vehicle and arranged to provide a signal indicative of an impact to the electronic control unit, the electronic control unit being operably connected to an actuator forming part of the actuator assembly and is arranged to energise the actuator when a signal indicative of an impact is received. The actuator may be pyrotechnically activated and the electronic control unit arranged to fire a pyrotechnic charge when a signal indicative of an impact is received.

The vehicle may include at least one bonnet latch to hold the bonnet in a closed position so that the or each bonnet latch is released upon actuation of the actuator assembly, in which case the or each bonnet latch may be released by a mechanical linkage connected at one end to the respective bonnet latch and connected at an opposite end to part of a respective hinge assembly. Alternatively, the or each bonnet latch may be an electronically operable latch operably connected to the electronic control unit, the or each electronically operable latch being arranged to be released by the electronic control unit when an energisation signal is sent to the actuator.

Preferably, the hinge mechanism comprises upper and lower leaves and upper and lower links which form the four bar linkage and an intermediate link joining the upper and lower links to form the five bar linkage upon release of the locking means. In such a case, the hinge assembly conveniently comprises the hinge mechanism having the lower hinge leaf connected to part of the body structure of the vehicle, the upper hinge leaf connected to part of the bonnet, the lower link pivotally connected at a first end by a first pivot means to the lower hinge leaf and at a second end by a second pivot means to the upper hinge leaf, the intermediate link pivotally connected at first end to the first pivot means and pivotally connected at a second end by means of a third pivot means to a first end of the upper link which has a second end pivotally connected by a fourth pivot means to the upper hinge leaf and the actuator assembly comprising a first member pivotally connected at a lower end to part of the vehicle body structure and a second member extending upwardly and rearwardly from the first member for pivotal connection at an upper end thereof to the third pivot means, the first pivot means being slidably supported in a slot formed in the lower hinge leaf and the third pivot means being attached to the lower hinge leaf by the locking means so as to be releasable when a force beyond a pre-determined level is applied to the third pivot means by the actuator assembly. Upon release of the locking means, the first

pivot means may be arranged to be urged rearwardly from a forward position in the slot by the action of the second member on the third pivot means.

The length of the slot in the lower hinge leaf is preferably such that when the second member has reached its maximum extended position the first pivot means has moved rearwardly a distance less than the total length of the slot in the lower hinge leaf.

The second member may be connected to the third pivot means by means of a transfer member, in which case the transfer member may be pivotally connected to the third pivot means at a first position and is pivotally connected to the second member at a second lower position by means of a fifth pivot means. Conveniently, the transfer member has an upper abutment surface for abutment against a lower edge of the upper link. The relative positions of the first and second positions is preferably such that the application of a force to the transfer member from the second member produces a turning moment urging the abutment surface against the lower edge of the upper link. In such a case, the action of the abutment surface against the upper link may be arranged to cause the upper link to be rotated relative to the intermediate link such the second end of the upper link is moved upwardly. Preferably, the included angle between upper edges of the intermediate and upper links is reduced by the rotation of the upper link relative to the intermediate link.

Conveniently, the releasable part of the locking means is a shear pin. The shear pin may be engaged with respective apertures in the lower hinge leaf and in the transfer member. Furthermore, the shear pin may be engaged with respective apertures in the lower hinge leaf and in the intermediate link.

The hinge assembly may include a latching means to selectively hold the first pivot means in a forward position in the slot after release of the locking means so as to

facilitate normal opening of the bonnet. Conveniently, the latching means is arranged to releasably connect the first pivot means to the lower hinge leaf. The latching means may be a C-shaped member attached at one end to the lower hinge leaf for engagement with the first pivot means, in which case the first pivot means may be a pivot pin, a roller being rotatably supported by the pivot pin for engagement with the C-shaped member.

The first pivot means may be a pivot pin which is rotatably engaged towards one end thereof with a slide member retained within the slot.

The second pivot means may be connected to the upper hinge leaf forwardly with respect to the position of attachment of the fourth pivot means to the upper hinge leaf.

The first pivot means may be located in the slot in the lower hinge leaf forwardly with respect to the position of the third pivot means.

Preferably, the lower link is longer than the upper link.

Preferably, the lower link is shorter than the combined length of the intermediate and upper links.

According to a second aspect of the invention there is provided a hinge assembly for use in a motor vehicle in accordance with said first aspect of the invention.

The invention will now be described by way of example with reference to the accompanying drawings, of which:-

Fig.1 is a side view of the front portion of a motor vehicle according to the invention and showing the movement of a bonnet in a first or normal mode of operation;

Fig.2 is a side view of the motor vehicle shown in Fig.1 but showing the movement of the bonnet in a second or crash mode of operation;

Fig.3 is a perspective view of a right hand lower hinge leaf forming part of a hinge assembly shown in Fig.1;

Fig. 4 is a lower side plan view of a right hand upper hinge leaf forming part of the hinge assembly shown in Fig.1;

Fig. 5 is an end view of the upper hinge leaf shown in Fig.4;

Fig. 6 is a side view of the upper hinge leaf shown in Fig.4;

Fig. 7 is an reverse angle view of the upper hinge leaf shown in Fig.4

Fig.8 is a perspective view of a hinge mechanism forming part of the hinge assembly shown in Fig.1;

Figs. 8A and 8B are perspective views of a transfer member forming part of the hinge assembly shown in Fig.1;

Fig.9 is a plan view of an actuator assembly forming part of the hinge assembly shown in Fig.1;

Fig.10 is a perspective view of the actuator assembly shown in Fig.9;

Fig.11 is a side view of the actuator assembly shown in Fig.9;

Fig.12 is a side view of the hinge mechanism shown in Fig.8 as seen in the direction of arrow A in Fig.13;

Fig.13 is a lower side plan view of the hinge mechanism shown in Fig.8

Fig.13A is a side view of a latching means forming part of the hinge mechanism shown in Fig.8;

Fig.14 is a cutaway side view of the motor vehicle shown in Fig. 1 showing the hinge assembly in greater detail;

Figs 15 is a perspective view of the hinge assembly shown in Fig.1 with the hinge mechanism shown in a normal operating position.

Figs 16 to 21 are perspective views based on Fig. 15 showing the hinge mechanism as it moves progressively from the normal operating position as shown in Fig. 15 to a raised position as shown in Fig. 21.

With particular reference to Figs.1 and 2 there is shown a motor vehicle 1 having a body structure 2 and a rear hinged bonnet 3. The bonnet 3 is pivotally connected to the body structure 2 towards a rear edge of the bonnet by two hinge assemblies 10 each located towards respective right and left hand sides of the bonnet 3. Each hinge assembly 10 comprises a hinge mechanism 4 and an actuator assembly 30 which are described in greater detail hereinafter.

During a first or normal mode of operation the hinge assembly 10 and in particular the hinge mechanism 4 is arranged to facilitate normal opening and closing of the bonnet 3. In a normally closed position the bonnet 3 is in a substantially horizontal position and obscures from view the contents of an engine bay of the motor vehicle 1.

To open the bonnet 3, a bonnet latch 7 is first released and the bonnet can then be lifted from a front edge thereof into an open position as indicated by the reference numeral 3A on Fig.1. A mechanical linkage between the bonnet latch 7 and the hinge mechanism 4 is provided in the form of a Bowden cable 8.

The vehicle 1 has an electronic control unit 5 and sensor means 6 mounted in a forward position on the vehicle, e.g. on a front bumper, to sense the impact of the vehicle with another object. It will be appreciated that there may be several sensors mounted at different positions across the front portion of the motor vehicle 1 to form the sensor means or the sensor means could be formed by a forward looking device such as radar.

The sensor means 6 is operably connected by means of an electric cable 9 to the electronic control unit 5 and is arranged to provide a signal indicative of an impact to the electronic control unit 5. That is to say, the signal could be indicative that an impact is actually occurring or could be indicative that an impact is about to occur depending upon the type of sensor used. The electronic control unit 5 is operably connected by a wire 35A to a pyrotechnic actuator 35 forming part of the actuator assembly 30 and is arranged to energise or fire the pyrotechnic actuator 35 when a signal indicative of an impact is received from the sensor means 6.

The pyrotechnic actuator 35 includes a pyrotechnic charge (not shown) which is fired when a signal indicative of an impact is received from the electronic control unit 5. It will be appreciated that the signal from the electronic control unit 5 may be a low power control signal used to energise a high power secondary unit to fire the charge or the electronic control unit could include high power output components to allow it to directly fire the pyrotechnic charge. When the pyrotechnic charge is fired the actuator assembly is operable to move the hinge mechanism in a second mode of operation such that the rear edge of the bonnet is raised as is shown in Fig.2. It will further be appreciated that other forms of actuator could be used such as a source of high pressure gas or liquid and the actuator may include a valve controlled by the electronic control unit used to admit the high pressure gas or fluid.

To assist with lifting of the rear edge of the bonnet 3, the bonnet latch 7 is released upon energisation of the actuator assembly 30. This allows the front edge of the bonnet 3 to move more easily with respect to the vehicle body structure 2. The release of the bonnet latch 7 is achieved by using the mechanical linkage 8 which is connected at one end to the bonnet latch 7 and at an opposite end to a part of the hinge mechanism 4 that is moved by the energisation of the actuator assembly 30. If there are two hinge assemblies and only one bonnet latch then the bonnet latch would be mechanically connected to only one of the hinge assemblies but if there are two

bonnet latches and two hinge assemblies then each of the bonnet latches will connected to one of the hinge assemblies.

It will be further appreciated that instead of a mechanical connection to each bonnet latch, the bonnet latch could be an electronically operable latch which is operably connected to the electronic control unit directly by an electric cable or wire. With such an arrangement each electronically operable latch could be arranged to be released by the electronic control unit directly when an energisation signal is sent to the actuator assembly.

Although release of the bonnet latch is desirable it may not be necessary with all constructions and arrangements of bonnet depending upon the type of bonnet latch used and the clearance between the front edge of the bonnet and the body structure surrounding the bonnet.

With particular reference to Figs 9 to 11 there is shown in greater detail an actuator assembly 30 forming part of the hinge assembly 10. The actuator assembly comprises a first member in the form of a body 31 which defines a closed cylinder in which is slidably mounted a second member in the form of a piston 32 having an elongate piston rod 33 which terminates in an eye 34 adapted for co-operation with a fifth pivot means 20 used to pivotally connect the piston 32 to a transfer member 60. An eye 36 is formed at the lower end of the body 31 for co-operation with a sixth pivot means 21 used to pivotally connect the body 31 to a bracket 37 forming part of the vehicle body structure 2. The pyrotechnic actuator 35 is located towards the lower end of the body 31 and is filled with a pyrotechnic material or charge (not shown), being connected via a passageway (not shown) to the lower end of the cylinder defined by the body 31.

The actuator assembly 30 is positioned such that the piston rod 33 extends upwardly and rearwardly from the body 31 for pivotal connection by means of the eye 34 to the third pivot means 18 via the transfer member 60. The body 31 also extends upwardly and rearwardly from its position of attachment to the body structure 2.

When the pyrotechnic charge is fired, a large volume of gas is rapidly produced and this causes the piston 32 to be moved rapidly along the cylinder, thereby extending the piston rod 33. A piston damper (not shown) is located within the upper end of the cylinder to decelerate the piston 32 at the end of its travel.

It will be appreciated that the actuator assembly specifically described could be replaced by alternative arrangements. For example, the first member could be a piston fixed to the body structure and the piston of the described embodiment could be replaced by a cylinder attached to the transfer member.

With particular reference to Figs 3 to 8 and 12 to 13A there is shown, in greater detail, the hinge mechanism 4 which forms part of the hinge assembly 10. In Fig.3 there is shown a lower hinge leaf 11 which is generally of an inverted U shape, having a first flange 40 for connection to part of the body structure 2 of the motor vehicle 1, a second flange 41 for connection to part of the body structure 2 of the motor vehicle 1, a first side wall 42, a second side wall 43 and a top wall 44 joining together the first and second side walls 42, 43. The first flange 40 has two apertures 45 used to accommodate threaded fasteners (not shown) which connect the first flange 40 to part of the vehicle body structure 2, the second flange 41 having two apertures 46 for the same purpose. The top wall 44 has two apertures 47 to accommodate fasteners (not shown) used to fasten a latching means (described later) to the lower hinge leaf 11. The second side wall 43 has a longitudinally extending slot 48 and a hole 49 for co-operation with a shear pin 39 forming part of a locking means, the slot 48 having an

enlarged end portion at a rear end thereof for permitting the insertion of a slider 27 (described later).

The terms rear and front and rearward and forward refer to directions relating to the motor vehicle and when used in connection to the hinge assembly refer to such directions when the assembly is attached in a normal position on the motor vehicle. For example, movement in a rearward direction of a component means that the component is moving towards the rear end of the vehicle. Similarly, upwardly and downwardly refer to upward and downward movements when the components are in their normal, in use, positions attached to the vehicle 1.

With particular reference to Figs 4 to 7 there is shown in greater detail an upper hinge leaf 12 forming part of the hinge mechanism 4. The upper hinge leaf 12 is substantially U shaped and has a top flange 50, a side wall 51 and first and second downwardly depending limbs 52, 53. The top flange 50 has a number of apertures 54 to accommodate fasteners such as bolts or rivets used to fasten the upper hinge leaf 12 to the bonnet 3. The side wall 51 has an aperture 55 which forms part of a second pivot means 17 and the first limb 52 has an aperture 56 which forms part of a fourth pivot means 19. The aperture 55 in the side wall 51 is positioned forwards of the aperture 56 in the first limb 52 to achieve the correct positioning for the second and fourth pivot means 17 and 19.

With particular reference to Fig 8 and Figs 12 to 13A there is shown in greater detail the hinge mechanism 4 as assembled. The hinge mechanism 4 comprises the lower hinge leaf 11, used to fasten the hinge mechanism 4 to part of the vehicle body structure 2 and the upper hinge leaf 12 used to fasten the hinge mechanism 4 to part of the bonnet 3. A lower link 13 is pivotally connected at a first end 22A by a first pivot means 16 to the lower hinge leaf 11 and at a second end 22B by the second pivot means 17 to the upper hinge leaf 12. An intermediate link 14 is pivotally connected at

first end 23A to the first pivot means 16 and at a second end 23B by means of a third pivot means 18 to a first end 24A of an upper link 15, the upper link 15 having a second end 24B pivotally connected by the fourth pivot means19 to the upper hinge leaf 12. The first pivot means 16 is slidably supported in the slot 48 formed in the second side wall 43 of the lower hinge leaf 11 by the slider 27 and the third pivot means 18 is attached to the lower hinge leaf 11 by the locking means.

The locking means is releasable when a force beyond a pre-determined level is applied to the third pivot means 18 and, when released, the first pivot means 16 can move rearwardly from its normal forward position in the slot 48 to a more rearward position and the third pivot means 18 is no longer fastened to the lower hinge leaf 11. In a preferred example, the force required to release the locking means for each hinge assembly is approximately 3000N and the force provided from the actuator assembly is approximately 6000N.

The length of the slot 48 in the lower hinge leaf 11 is such that, when the piston 32 has reached its maximum extended position, the first pivot means 16 and, in particular, the slider 27 have moved rearwards by a distance which is less than the total length of the slot 48. This is important because, if the slider 27 abuts the end of the slot 48 before the piston 32 has finished moving, a large impact force will be applied to the third pivot means 18 and to the piston rod 33. Such an impact force may damage these components and also the bonnet 3. The free travel at the end of the slot 48 allows the bonnet 3 and the attached links 13, 14, 15 to continue to move under the effect of the inertia in the system and then settle back slightly onto the fully extended piston 32. This can have beneficial effects with respect to an impact loads transferred to a person who falls upon the bonnet 3 because the bonnet 3 is then able to move in a sympathetic manner with the person to absorb some of the impact. Conversely, if the bonnet were to be held rigidly up by a fully extended piston 32, the impact is likely to be less sympathetic. Ideally the actuator assembly is arranged to

move the bonnet such that the piston 32 is fully extended before the person impacts the bonnet 3. In a preferred example, the piston 32 has reached the end of its travel after approximately 40ms whereas the head of a pedestrian is known not to contact the bonnet until 100 ms after impact.

The arrangement allows the hinge mechanism 4 to operate during a normal mode as a conventional four bar hinge mechanism to facilitate normal opening and closing of the bonnet 3. In this mode, the lower and upper links 13 and 15 form the four bar linkage in combination with the lower and upper hinge leaves 11 and 12. However, when the locking means is released, a second mode of operation is possible in which the rear edge of the bonnet 3 is lifted relative to the surrounding body structure 2. In this mode of operation the lower, intermediate and upper links 13, 14 and 15 form in combination with the lower and upper hinge leaves 11 and 12 a five bar linkage.

The lower link is in the form of an elongate steel lower arm 13 and has an aperture in its first end 22A which is engaged with a pivot pin 16A which is also engaged with an aperture in the first end 23A of the intermediate link 14. The intermediate link is in the form of an elongate steel slider arm 14 and has a further aperture in a second end 23B for co-operation with a pivot pin 18A forming part of the third pivot means 18. The pivot pin 16A is engaged at one end with an aperture formed in the slider 27 which is slidingly supported by the slot 48. The slider 27 is provided to improve sliding of the first pivot means 16 along the slot 48 during transition into the second mode of operation. The pivot pin 16A, in combination with the slider 27 and the slot 48, thus forms the first pivot means 16 which is used to pivotally connect the lower and slider arms 13 and 14 at their respective first ends 22A, 23A to the lower hinge leaf 11.

A roller 16 is rotatably mounted on the pivot pin 16A for co-operation with a C-shaped latch 25 which together form the latching means used to selectively hold the

first pivot means 16 at a forward position in the slot 48. During normal use this is not required because the first pivot means is held in a forward position by the slider arm 14 which is locked to the lower hinge leaf 11 by the locking means. In this position the lower arm 13 can only rotate relative to the lower hinge leaf 11 and cannot slide in the slot 48.

When the locking means has been released, the first pivot means is free to slide longitudinally along the slot 48. However, if the rear edge of the bonnet 3 is pressed firmly down, the latching means can be used to hold the bonnet temporarily in a normal closed position thereby allowing the vehicle to be driven. This feature is particularly useful if the locking means has been released inadvertently and the rear edge of the bonnet 3 is raised but no vehicle damage has occurred. In such circumstances, it is useful to be able to reset the bonnet to drive the vehicle home or to a garage to have the pyrotechnic charges replaced.

The pivot pin 18A is engaged not only with the aperture in the second end 23B of the slider arm 14 but also with corresponding apertures in the upper link 15 and a transfer member 60. The upper link 15 is formed by two identical elongate steel upper arms 15A and 15B, each of which has an aperture in a first end 24A thereof for co-operation with the pivot pin 18A and an aperture in a second end thereof for co-operation with a pivot pin 19A forming part of the fourth pivot means 19. The second pivot means 17 is connected to the upper hinge leaf 12 forwards of the position of attachment of the fourth pivot means 19 to the upper hinge leaf 12 and the first pivot means 16 is located in the slot 48 in the lower hinge leaf 11 forwards of the position of the third pivot means 18.

The lower arm 13 is longer than the upper arm 15 and, in combination with the relative positioning of the first and third and second and fourth pivot means 16 and 18 and 17 and 19, forms a conventional four bar linkage in which the bonnet 3 moves

upwardly and slightly forwardly as it is opened. However, when the releasable locking means is released, a different kinematic situation is produced and the lower arm 13 is then shorter than the combined length of the intermediate and upper arms 14 and 15. Furthermore, because the lower arm 13 moves backwards in the slot 48 to a position in which it lies almost vertically below the second pivot means, the vertical displacement of the bonnet is greatly increased.

The transfer member 60 is U shaped and has two side walls 61A, 61B joined by a flange 62. The flange 62 has a plate 64 attached thereto which has an upper surface which forms an upper abutment surface 63 for co-operation with a lower edge 15C, 15D of each of the upper arms 15A, 15B. Each side wall 61A, 61B of the transfer member 60 has a first aperture 65 at a first position for co-operation with the pivot pin 19A and a second aperture 66 at a second position for co-operation with a pivot pin 20A which forms part of a fifth pivot means 20 used to pivotally connect the transfer member 60 to the actuator assembly 30. Each side wall 61A, 61B also has a third aperture 67 for co-operation with the shear pin 39. The locking means is therefore formed by the shear pin 39 in combination with apertures 67 in the transfer member 60 and aperture 49 in the lower hinge leaf 11.

It will be appreciated that the locking means could alternatively be formed by using a shear pin engaged with respective apertures in the lower hinge leaf and in the intermediate link. This arrangement would lock the lower hinge leaf to the slider arm but would not normally be the preferred option because the transfer member acts directly on the shear pin and thus is particularly efficient in shearing the shear pin.

It will be appreciated that other means could be used to provide the locking means and it is feasible to provide a locking means that is re-settable after activation of the pyrotechnic charge. In such a case the latching means previously described may not be required because, once the third pivot means 18 is re-attached to the lower

hinge leaf 11, the first hinge means would be retained in its forward position by the slider arm 14.

The first aperture 65 is positioned above the second aperture 66 and is displaced forwardly with respect to the second aperture 66 and the upper abutment surface 63. The relative locations of the first and second positions is such that the application of a force to the transfer member 60 from a piston 32 forming part of the actuator assembly 30 will produce a turning moment urging the upper abutment surface 63 against the lower edges 15C, 15D of the upper arms 15A, 15B. The action of the upper abutment surface 63 against the upper arms 15A, 15B is very beneficial because it causes the upper arms 15A, 15B to be rotated relative to the slider arm 14 such the second ends 24B of the upper arms 15A, 15B are moved upwardly. In particular, the included angle between respective upper edges of the intermediate and upper arms 14 and 15A, 15B is reduced by the rotation of the upper arms 15A, 15B relative to the slider arm 14. This folding action is important because if the arms 14, 15A, 15B fold such that the included angle is increased then the effectiveness of the hinge mechanism 4 in lifting the rear edge of the bonnet 3 is greatly reduced. The transfer member 60 is therefore advantageous to the operation of the hinge mechanism 4 and is also beneficial to the whole hinge assembly because not only does it perform the above function it also connects the piston 32 to the third pivot means18 and forms a part of the locking means.

Although the piston could be directly connected to the third pivot means 18 this has certain disadvantages. A primary disadvantage is that the motion of the piston when directly linked to the third pivot means would cause bending of the piston rod 33 as it is extended from the body 31. This is particularly the case if the body is located close to the position of connection to the third pivot means 18. If the body is located some distance from the third pivot means 18 and a very long piston rod 33 is used then the problem is minimised but it is then very difficult to package the actuator

assembly within the wheel arch area of the motor vehicle body. In addition, when the piston 32 is connected directly to the third pivot means 18 the angle of the piston is critical to ensure correct folding of the hinge mechanism.

Operation of the hinge assembly is best understood with reference to Figs.1, 2, 14 and 15 to 21. When the hinge assembly is in its first operation mode the first pivot means 16 is held at the front of the slot 48 and the third pivot means 18 is held to the lower hinge leaf 11 so that the mechanism functions as a conventional four bar linkage. However, when an impact at the front of the vehicle 1 occurs, the pyrotechnic actuator 35 is fired by the electronic control unit 5 and the piston rod 33 is urged upwardly by the rapidly expanding gas trapped in the body 31. This movement and particular the force produced is transferred from the piston 32 into the transfer member 60. Because the force produced by the actuator assembly 30 is far greater than that normally present in the hinge mechanism 4 it causes shearing of the shear pin 39. The shear pin 39 is designed to fail when a force greater than a predetermined magnitude is applied to it. The pre-determined magnitude is considerably greater than the force normally exerted upon the shear pin during operation of the hinge mechanism in the first mode.

As soon as the shear pin 39 is broken the third pivot means 18 is decoupled from the lower hinge means 11. Just as importantly, the transfer member 60 is then free to rotate about the third pivot means 18 to cause abutment of the upper abutment surface 63 with the two upper arms 15A, 15B. This causes the arms 15A, 15B to be folded upwardly and also, because of the transfer of force via the third pivot means 18 into the slider arm 14, causes the first pivot means 16 to be moved rearwardly in the slot 48. This rearward movement of the first pivot means 16 not only allows the first pivot means 16 to move to a position in which it lies closer to a position vertically below the second pivot means 17 but also allows the slider arm 14 to pivot about the first pivot means 16, thereby causing the third pivot means 18 to move upwardly relative to the

lower hinge leaf 11. In effect, the third pivot means is moved along an arc whose path is described by a function related to the rearward displacement of the first pivot means 16, the length of the slider arm 14 and the upward movement of the piston 3. This combination of rotation of the intermediate and upper arms 14 and 15A, 15B results in the upper hinge leaf 12 and hence the attached bonnet being moved rapidly upwards and by an amount that is greater than length of the upper arms 15A, 15B.

As soon as the piston 32 has reached the end of its stroke, the inertia of the bonnet 3 will cause the bonnet 3 to move a small distance further in an upwardly direction and at this time the upper arms 15A, 15B move away from the upper abutment surface 63 and are no longer is contact with it. As soon as the inertia effects have ceased the upper arms 15A, 15B rotate back slightly to re-establish abutment with the upper abutment surface 63. The rear edge of the bonnet 3 is then held in this raised position by the residual gas pressure in the cylinder of the actuator assembly 30.

After a few minutes has elapsed, the pressure in the cylinder reduces to the extent that the application of a firm downward pressure on the bonnet 3 is sufficient to push the piston 32 back into the cylinder and allow the bonnet 3 to move down into a normal closed position. During this action, the roller 26 engages with the C shaped latch 25 of the latching means to retain the first pivot means 16 back in its original forward position within the slot 48. This enables the vehicle to be driven if the bonnet 3 is not seriously damaged. This may be the case if the vehicle has run into another vehicle at low speed or if the actuator mechanism has been fired inadvertently.

It will be appreciated that when the rear edge of the bonnet has been lifted to its fullest extent by the hinge assembly there is a considerable clearance between the bonnet and any engine components located within the engine bay. Therefore if the bonnet itself is dented inwardly by a person falling upon it then the bonnet is able to

deform to absorb the energy of impact for a considerable distance before contact with any rigid engine component occurs. This enables the bonnet to absorb a considerable amount of energy and effectively soften the impact for the person. In addition, if the timing of the bonnet raising is correctly arranged the moment of impact will occur at or just after the moment when the bonnet reaches its highest point and is starting to fall. This can further soften the impact because the bonnet and the person are then moving in the same direction and so the relative velocity between them is reduced compared to the situation of contact with a rising bonnet or a stationary bonnet.

Although the invention has been described by way of example with reference to an embodiment in which the actuator assembly reacts directly against the hinge mechanism and is connected thereto it will be appreciated that there could be a single actuator assembly located at the rear of the bonnet remotely from the hinge mechanisms and that actuation of the actuator assembly would then result in a force being transferred from the actuator assembly to the hinge mechanisms to release the locking means. Alternatively, there could be two actuator assemblies one mounted adjacent each of the two hinge mechanisms. However, such arrangements are not considered to be as convenient as the arrangement described in detail above because the deployment forces are transmitted through the bonnet.

It will appreciated that the invention has been described by way of example and that alternative embodiments can be constructed without departing from the scope of this invention.

CLAIMS

1. A motor vehicle having a body structure and a bonnet pivotally connected to the body structure towards a rear edge of the bonnet by one or more hinge assemblies and at least one actuator assembly selectively operable so as to cause the rear of the bonnet to be moved from its normal position to a raised position when the actuator assembly is actuated wherein each hinge assembly comprises a hinge mechanism having a four bar linkage operable during normal use to pivotally connect the rear hinged bonnet to the body structure of the motor vehicle so as to facilitate normal opening and closing of the bonnet and a locking means to hold the hinge mechanism in its normal position, the arrangement being such that the or each actuator assembly, when operated, releases the locking means and raises the rear edge of the bonnet.

2. A motor vehicle as claimed in claim 1 in which, when the locking means is released, a five bar linkage is formed which facilitates the raising of the rear edge of the bonnet.

3. A motor vehicle as claimed in claim 1 or in claim 2 in which each actuator assembly is operatively connected to part of a respective hinge mechanism and is selectively operable to act upon said part of the hinge mechanism so as to cause the rear of the bonnet to be moved from its normal position to a raised position when the actuator assembly is actuated.

4. A motor vehicle as claimed in any preceding claim and further comprising an electronic control unit and at least one sensor means mounted in a forward position on the vehicle and arranged to provide a signal indicative of an impact to the electronic control unit, the electronic control unit being operably connected to an actuator forming part of the actuator assembly and is arranged to energise the actuator when a signal indicative of an impact is received.

5. A motor vehicle as claimed in claim 4 in which the actuator is pyrotechnically activated and the electronic control unit is arranged to fire a pyrotechnic charge when a signal indicative of an impact is received.

6. A motor vehicle as claimed in any preceding claim and further including at least one bonnet latch to hold the bonnet in a closed position so that the or each bonnet latch is released upon actuation of the actuator assembly.

7. A motor vehicle as claimed in claim 6 in which the or each bonnet latch is released by a mechanical linkage connected at one end to the respective bonnet latch and connected at an opposite end to part of a respective hinge assembly.

8. A motor vehicle as claimed in claim 6 when dependent upon claim 4 in which the or each bonnet latch is an electronically operable latch and is operably connected to the electronic control unit, the or each electronically operable latch being arranged to be released by the electronic control unit when an energisation signal is sent to the actuator.

9. A motor vehicle as claimed in any preceding claim in which the hinge mechanism comprises upper and lower leaves and upper and lower links which form the four bar linkage and an intermediate link joining the upper and lower links to form the five bar linkage upon release of the locking means.

10. A motor vehicle as claimed in claim 9 wherein the hinge assembly comprises the hinge mechanism having the lower hinge leaf connected to part of the body structure of the vehicle, the upper hinge leaf connected to part of the bonnet, the lower link pivotally connected at a first end by a first pivot means to the lower hinge leaf and at a second end by a second pivot means to the upper hinge leaf, the intermediate link pivotally connected at first end to the first pivot means and

pivotally connected at a second end by means of a third pivot means to a first end of the upper link which has a second end pivotally connected by a fourth pivot means to the upper hinge leaf and the actuator assembly comprising a first member pivotally connected at a lower end to part of the vehicle body structure and a second member extending upwardly and rearwardly from the first member for pivotal connection at an upper end thereof to the third pivot means, the first pivot means being slidably supported in a slot formed in the lower hinge leaf and the third pivot means being attached to the lower hinge leaf by the locking means so as to be releasable when a force beyond a pre-determined level is applied to the third pivot means by the actuator assembly.

11. A motor vehicle as claimed in claim 9 or in claim 10 in which, upon release of the locking means, the first pivot means is urged rearwardly from a forward position in the slot by the action of the second member on the third pivot means.

12. A motor vehicle as claimed in any of claims 9 to 11 in which the length of the slot in the lower hinge leaf is such that when the second member has reached its maximum extended position the first pivot means has moved rearwardly a distance less than the total length of the slot in the lower hinge leaf.

13. A motor vehicle as claimed in any of claims 9 to 12 in which the second member is connected to the third pivot means by means of a transfer member.

14. A motor vehicle as claimed in claim 13 in which the transfer member is pivotally connected to the third pivot means at a first position and is pivotally connected to the second member at a second lower position by means of a fifth pivot means.

15. A motor vehicle as claimed in claim 13 or in claim 14 in which the transfer member has an upper abutment surface for abutment against a lower edge of the upper link.

16. A motor vehicle as claimed in claim 15 when dependent upon claim 14 in which the relative positions of the first and second positions is such that the application of a force to the transfer member from the second member produces a turning moment urging the abutment surface against the lower edge of the upper link.

17. A motor vehicle as claimed in claim 16 or in claim 17 in which the action of the abutment surface against the upper link causes the upper link to be rotated relative to the intermediate link such the second end of the upper link is moved upwardly.

18. A motor vehicle as claimed in claimed 17 in which the included angle between upper edges of the intermediate and upper links is reduced by the rotation of the upper link relative to the intermediate link.

19. A motor vehicle as claimed in any preceding claim in which the releasable part of the locking means is a shear pin.

20. A motor vehicle as claimed in claim 19 when dependent upon any of claims 13 to 18 in which the shear pin is engaged with respective apertures in the lower hinge leaf and in the transfer member.

21. A motor vehicle as claimed in claim 20 in which the shear pin is engaged with respective apertures in the lower hinge leaf and in the intermediate link.

22. A motor vehicle as claimed in any of claims 11 to 21 in which the hinge assembly includes a latching means to selectively hold the first pivot means in a forward

position in the slot after release of the locking means so as to facilitate normal opening of the bonnet.

23. A motor vehicle as claimed in claim 22 in which the latching means is arranged to releasably connect the first pivot means to the lower hinge leaf.

24. A motor vehicle as claimed in claim 22 or claim 23 in which the latching means is a C-shaped member attached at one end to the lower hinge leaf for engagement with the first pivot means.

25. A motor vehicle as claimed in claim 24 in which the first pivot means is a pivot pin and a roller is rotatably supported by the pivot pin for engagement with the C-shaped member.

26. A motor vehicle as claimed in any of claims 9 to 25 in which the first pivot means is a pivot pin which is rotatably engaged towards one end thereof with a slide member retained within the slot.

27. A motor vehicle as claimed in any of claims 9 to 26 in which the second pivot means is connected to the upper hinge leaf forwardly with respect to the position of attachment of the fourth pivot means to the upper hinge leaf.

28. A motor vehicle as claimed in any of claims 9 to 27 in which the first pivot means is located in the slot in the lower hinge leaf forwardly with respect to the position of the third pivot means.

29. A motor vehicle as claimed in any of claims 8 to 28 in which the lower link is longer than the upper link.

30. A motor vehicle as claimed in any of claims 8 to 29 in which the lower link is shorter than the combined length of the intermediate and upper links.

31. A motor vehicle as claimed in any of claims 8 to 30 in which the lower link is an elongate arm.

32. A motor vehicle as claimed in any of claims 8 to 31 in which the intermediate link is an elongate arm.

33. A motor vehicle as claimed in any of claims 8 to 32 in which the upper link is formed by at least one elongate arm.

34. A motor vehicle as claimed in claim 33 in which the upper link is formed by two identical elongate arms.

35. A motor vehicle as claimed in any of claims 8 to 34 in which the actuator assembly further comprises a pyrotechnic actuator.

36. A hinge mechanism for use in a motor vehicle having a body structure and a bonnet pivotally connected to the body structure towards a rear edge of the bonnet by one or more of said hinge mechanisms and at least one actuator assembly selectively operable so as to cause the rear of the bonnet to be moved from its normal position to a raised position when the actuator assembly is actuated, the motor vehicle being as claimed in any preceding claim.

37. A hinge assembly for connecting a rear hinged bonnet to part of the body structure of a motor vehicle and substantially as described herein with reference to the accompanying drawings.

38. A motor vehicle substantially as described herein with reference to the accompanying drawings.

Application No:	GB 0304449.2	**Examiner:**	Beverley Lloyd
Claims searched:	1 - 36	**Date of search:**	29 May 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 3 - 5, 19 & 36	GB 2381508 A (FORD) See Figs & line 10 - 14, page 3 at least

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

B7B, E2F

Worldwide search of patent documents classified in the following areas of the IPC[7]:

B60R, B62D

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO